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World Intellectual Property Organization (WIPO) - Geneva, Switzerland  
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1308955

# THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

*April 14, 2005*

**THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.**

**APPLICATION NUMBER: 60/556,463**

**FILING DATE: *March 25, 2004***

**RELATED PCT APPLICATION NUMBER: *PCT/US05/09500***



Certified by

Under Secretary of Commerce  
for Intellectual Property  
and Director of the United States  
Patent and Trademark Office

18379 U.S. PTO  
032504

Practitioner's Docket No. WLI-001PR

**PATENT**

13441 U.S. PTO  
60/556463

032504

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P., § 601, 7th ed.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of: George D. Whitten et al.

For: Ultraviolet Laser System for Decomposing Chemical Pollutants

Mail Stop Provisional Patent Application

Commissioner for Patents

P.O. Box 1450, Alexandria, VA 22313-1450

**COVER SHEET FOR FILING PROVISIONAL APPLICATION**  
(37 C.F.R. § 1.51(c)(1))

**WARNING:** "A provisional application must also include the cover sheet required by § 1.51(c)(1) or a cover letter identifying the application as a provisional application. Otherwise, the application will be treated as an application filed under paragraph (b) [nonprovisional application] of this section." 37 C.F.R. § 1.53(c)(1). See also M.P.E.P. § 201.04(b), 6th ed., rev. 3.

**EXPRESS MAILING UNDER 37 C.F.R. § 1.10\***

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I hereby certify that this paper, along with any document referred to, is being deposited with the United States Postal Service on this date March 25, 2004, in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 as "Express Mail Post Office to Addressee" Mailing Label No. ER 722918292 US

Leslie R. Silverstein

(type or print name of person mailing paper)

*Leslie R. Silverstein*

Signature of person certifying

**WARNING:** Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

**\*WARNING:** Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will not be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

(Cover Sheet for Filing Provisional Application [23-1]—page 1 of 5)

NOTE: "A complete provisional application does not require claims since no examination on the merits will be given to a provisional application. However, provisional applications may be filed with one or more claims as part of the application. Nevertheless, no additional claim fee or multiple dependent claims fee will be required in a provisional application." Notice of December 5, 1994, 59 Fed. Reg. 63,951, at 63,953.  
"Any claim filed with a provisional application will, of course, be considered part of the original provisional application disclosure." Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,209.

NOTE: "A provisional application is not entitled to the right of priority under 35 U.S.C. 119 or 365(a) or § 1.55, or to the benefit of an earlier filing date under 35 U.S.C. 120, 121 or 365(c) or § 1.78 of any other application. No claim for priority under § 1.78(a)(3) may be made in a design application based on a provisional application. No request under § 1.293 for a statutory invention registration may be filed in a provisional application. The requirements of §§ 1.821 through 1.825 regarding application disclosures containing nucleotide and/or amino acid sequences are not mandatory for provisional applications." 37 C.F.R. § 1.53(c)(3).

NOTE: "No information disclosure statement may be filed in a provisional application." 37 C.F.R. § 1.51(d).  
"Any information disclosure statements filed in a provisional application would either be returned or disposed of at the convenience of the Office." Notice of December 5, 1994, 59 Fed. Reg. 63,591, at 63,594.

NOTE: "No amendment other than to make the provisional application comply with the patent statute and all applicable regulations may be made to the provisional application after the filing date of the provisional application." 37 C.F.R. § 1.53(c).

NOTE: 35 U.S.C. 119(e)(1) requires that a nonprovisional application be filed within twelve months of the filing date of the provisional application for the nonprovisional application to claim the benefit of the filing date of the provisional application. Under 35 U.S.C. 21(b) and 119(e)(3), if this twelve-month period expires on a non-business day, it is extended to expire on the next business day.

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 C.F.R. § 1.51(c)(1)(i).

1. The following comprises the information required by 37 C.F.R. § 1.51(c)(1):
2. The name(s) of the inventor(s) is/are (37 C.F.R. § 1.51(c)(1)(ii)):

NOTE: "If the correct inventor or inventors are not named on filing a provisional application without a cover sheet under § 1.15(c)(1), the later submission of a cover sheet under § 1.15(c)(1) during the pendency of the application will act to correct the earlier identification of inventorship." 37 C.F.R. § 1.48(f)(2).

NOTE: "The naming of inventors for obtaining a filing date for a provisional application is the same as for other applications. A provisional application filed with the inventors identified as 'Jones et al.' will not be accorded a filing date earlier than the date upon which the name of each inventor is supplied unless a petition with the fee set forth in § 1.17(f) is filed which sets forth the reasons the delay in supplying the names should be excused. Administrative oversight is an acceptable reason. It should be noted that for a 35 U.S.C. 111(a) application to be entitled to claim the benefit of the filing date of a provisional application the 35 U.S.C. 111(a)[,] application must have at least one inventor in common with the provisional application." Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,209.

The term "invention" is typically used to refer to subject matter which applicant is claiming in his/her application. Because claims are not required in a provisional application, it would not be appropriate to reference joint inventors as those who have made a contribution to the "invention" disclosed in the provisional application. If the "invention" has not been determined in the provisional application because no claims have been presented, then the name(s) of those person(s) who have made a contribution to the subject matter disclosed in the provisional application should be submitted. Section 1.45(c) states that "if multiple inventors are named in a provisional application, each named inventor must have made a contribution, individually or jointly, to the subject matter disclosed in the provisional application." All that § 1.45(c) requires is that if someone is named as an inventor, that person must have made a contribution to the subject matter disclosed in the provisional application. When applicant has determined what the invention is by the filing of the 35 U.S.C. 111(a) application, that is the time when the correct inventors must be named. The 35 U.S.C. 111(a) application must have an inventor in common with the provisional application in order for the 35 U.S.C. 111(a) application to be entitled to claim the benefit of the provisional application under 35 U.S.C. 119(e). Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,208.

See 37 C.F.R. § 1.53.

1.	<u>George</u>	<u>D.</u>	<u>Whitten</u>
2. <input checked="" type="checkbox"/>	<u>Waheed</u>		<u>Mukaddam</u>
	<b>GIVEN NAME</b>	<b>MIDDLE INITIAL OR NAME</b>	<b>FAMILY (OR LAST) NAME</b>
3. <input checked="" type="checkbox"/>	<u>Allan</u>	<u>R.</u>	<u>Thompson</u>
	<b>GIVEN NAME</b>	<b>MIDDLE INITIAL OR NAME</b>	<b>FAMILY (OR LAST) NAME</b>
4. <input checked="" type="checkbox"/>	<u>Charles</u>	<u>W.</u>	<u>Moore</u>
	<b>GIVEN NAME</b>	<b>MIDDLE INITIAL OR NAME</b>	<b>FAMILY (OR LAST) NAME</b>

3. Residence address(es) of the inventor(s), as numbered above (37 C.F.R. § 1.51(c)(1)(iii)):

1. Box 147, West Boothbay Harbor, Boothbay, ME 04575
2. 72 Pleasant Street, Cambridge, MA 02139
3. 31 Holton Street, Winchester, MA 01890
4. 44 4 Deer Run, Wayland, MA 01778

4. The title of the invention is (37 C.F.R. § 1.51(c)(1)(iv)):

Ultraviolet Laser System for Decomposing Chemical Pollutants

5. The name, registration, customer and telephone numbers of the practitioner (if applicable) is (37 C.F.R. § 1.51(c)(1)(v)):

Name of practitioner: David Silverstein

Reg. No. 26,336 Tel. ( 978 ) 470-0990

Customer No. \_\_\_\_\_

(complete the following, if applicable)

☒ A power of attorney accompanies this cover sheet.

6. The docket number used to identify this application is (37 C.F.R. § 1.51(c)(1)(vi)):

Docket No.: WLI-001PR

7. The correspondence address for this application is (37 C.F.R. § 1.51(c)(1)(vii)):

David Silverstein

Andover-IP-Law, 44 Park Street, Suite 300, Andover, MA 01810

8. Statement as to whether invention was made by an agency of the U.S. Government or under contract with an agency of the U.S. Government.  
(37 C.F.R. § 1.51(c)(1)(viii))

This invention was made by an agency of the United States Government, or under contract with an agency of the United States Government.

☒ No.

☐ Yes.

The name of the U.S. Government agency and the Government contract number are: \_\_\_\_\_

9. Identification of documents accompanying this cover sheet:

A. Documents required by 37 C.F.R. §§ 1.51(c)(2)-(3):

Specification: (incl. cover page)

No. of pages 7

Drawings:

No. of sheets 1

B. Additional documents:

☒ Claims:

No. of claims 1

Note: See 37 C.F.R. § 1.51.

☒ Power of attorney

☒ Small entity assertion

☒ Assignment + Cover sheet + \$40.00 check for recording fee

☐ English language translation of non-English provisional application

NOTE: A provisional application which is filed in a language other than English, does not have to have an English language translation. See 37 C.F.R. § 1.52(d)(2). However, if the provisional application is not in the English language and will later serve as a benefit of its filing date for a nonprovisional application, other than a design patent, or for an international application designating the U.S., then an English language translation must be filed in the provisional application or the later filed nonprovisional application. See § 1.78(a)(5)(iv).

☐ This application is in a language other than English and an English translation along with a statement of its accuracy is submitted herewith.

☒ Other - Abstract (1 page)

10. Fee

The filing fee for this provisional application, as set in 37 C.F.R. § 1.16(k), is \$160.00, for other than a small entity, and \$80.00, for a small entity.

☒ Applicant is a small entity.

NOTE: "A . . . statement in compliance with existing § 1.27 is required to be filed in each provisional application in which it is desired to pay reduced fees." Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,197.

11. Small entity assertion

☐ The assertion that this is a filing by a small entity under 37 C.F.R. § 1.27(c)(1) is attached. ("ASSERTION OF SMALL ENTITY STATUS")

☒ Small entity status is asserted for this application by payment of the small entity filing fee under § 1.16(k). 37 C.F.R. § 1.27(c)(3).

12. Fee payment

☒ Fee payment in the amount of \$ 80.00 is being made at this time.

☐ No filing fee is to be paid at this time. (This and the surcharge required by 37 C.F.R. 1.16(l) can be paid subsequently).

**13. Method of fee payment**

☒ Attached is a ☒ check ☐ money order in the amount of \$ 80.00 / \$40.00

☒ Authorization is hereby made to charge ~~the amount of \$~~ any fee deficiency

☒ to Deposit Account No. 50-1139

☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

**WARNING:** Credit card information should *not* be included on this form as it may become public.

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

Date: \_\_\_\_\_

Tel.: (       )

Date: March 25, 2004

Reg. No.: 26,336

Tel.: ( 978 ) 470-0990

Customer No.:

\_\_\_\_\_  
Signature of submitter

OR

David Silverstein

\_\_\_\_\_  
Signature of practitioner

David Silverstein

\_\_\_\_\_  
(type or print name of practitioner)

Andover-IP-Law

P.O. Address

44 Park Street, Suite 300

Andover, MA 01810

PROVISIONAL

APPLICATION

FOR

UNITED STATES LETTER PATENT

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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that George D. Whitten of Boothbay, Maine, Allan R. Thompson of Winchester, Massachusetts, Charles W. Moores of Wayland, Massachusetts, and Waheed Mukaddam of Cambridge, Massachusetts have invented certain improvements in  
ULTRAVIOLET LASER SYSTEM FOR DECOMPOSING CHEMICAL POLLUTANTS of  
which the following description is a specification.



## **ULTRAVIOLET LASER SYSTEM FOR DECOMPOSING CHEMICAL POLLUTANTS**

### **FIELD OF THE INVENTION**

This invention relates generally to apparatus and methods for using an ultraviolet laser system to decompose chemical pollutants, for example organic contaminants such as perfluorooctanoate, in water.

### **BACKGROUND OF THE INVENTION**

There is a class of water soluble chemical compounds that appear in wastewater and groundwater and are of “environmental concern” even at concentrations in the parts per billion range. Examples of these compounds are chemicals such as polychlorinated bi-phenyls, dioxins, 1–4 dioxane, pentachlorophenol, perchlorate, tri and di-nitro toluene and perfluorooctanoate. Traditionally treatments for these compounds have included activated carbon adsorption, ultraviolet (lamp) catalyzed peroxide treatment, in-situ biological treatment, membrane filtration and containment. However, the physical, chemical and biological properties of these chemicals make recovery, removal and/or decomposition prior to discharge to the environment, at concentrations below “a threshold concentration of concern” very difficult, very expensive and in some cases impossible.

These and other deficiencies in or limitations of the prior art in this field are overcome in whole or at least in part by the ultraviolet laser system of this invention for decomposing chemical pollutants.

## OBJECTS OF THE INVENTION

A principal object of the present invention is to cost-effectively decompose various chemical water pollutants to concentrations that are acceptable to be discharged to the environment consistent with local, state, federal and/or other environmental regulations or pertinent health standards.

This and other objects, advantages and benefits of this invention will be better understood by the following description read in conjunction with Fig. 1.

## SUMMARY OF THE INVENTION

Because of the energy of ultraviolet photons and the concentration of ultraviolet photons from a laser source, it has been found in accordance with this invention that irradiation of water solutions of certain classes of polluting chemicals by means of an ultraviolet laser, in some cases with or in some cases without catalysts, will effectively and efficiently result in the decomposition of these compounds. A process in accordance with this invention utilizing an ultraviolet laser to decompose environmentally refractory chemicals in water results in a cost-effective method of realizing pollutant concentrations that are below the threshold concentrations of environmental concern and which can then be safely discharged to the environment.

## BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic process flow diagram illustrating one embodiment for carrying out an ultraviolet laser decomposition process in accordance with this invention.

## DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

A laboratory test system for carrying out an embodiment of the present invention is illustrated in the process flow diagram of Fig. 1. As shown in Fig. 1, the process elements consist of an ultraviolet laser, a reaction chamber to contain a sample of water and pollutant(s), an ultraviolet spectrometer and a computer. The laser beam is directed at the reaction chamber so as to irradiate the contents of the reaction chamber. Water containing a known concentration of the pollutant(s) is placed in the reaction chamber in accordance with this invention; and, the ultraviolet spectrophotometric signature and temperature of the contents of the reaction chamber are recorded before the laser is activated. Thereafter, the laser is activated, and the ultraviolet spectrophotometric signature and temperature of the contents of the reaction chamber are continuously measured and recorded. After a period of laser irradiation, usually less than about 15 minutes, for example from about 1 second to about 10 minutes, preferably from about less than 10 seconds to about less than 10 minutes, the ultraviolet spectrophotometric signature of the sample has been significantly changed indicating substantial decomposition and detoxification of the pollutant. The laser is turned off at this point or when further changes in the spectrophotometric monitoring show substantial completion of the decomposition reaction. The irradiated sample is removed from the reaction chamber for further analysis.

An irradiated sample can be analyzed, for example by means of FTIR analysis, to identify the decomposition products, and also by wet chemistry to determine the residual concentration(s) of the pollutant(s) remaining in the sample after the radiation step. The concentration(s) of the pollutant(s) in the irradiated sample is compared to the concentration(s) in a sample that has not been irradiated to judge the extent of the pollutant decomposition. Samples of varying concentrations of pollutants can be irradiated as described above, and data for these samples can

be recorded and compared. Catalysts such as iron and chemicals such as hydrogen peroxide can be utilized to facilitate, enhance, and/or expedite the decomposition reactions of this invention.

### Example

For example, in demonstrating the practice of one embodiment of this invention, a distilled water blank and various concentrations, ranging from about 5 ppm to about 500 ppm, of ammonium perfluorooctanoate (apfo) in distilled water were prepared. A portion of each apfo sample was saved as a reference and a portion of the sample was introduced into a 22mm diameter by 50mm long synthetic quartz (Suprasil<sup>TM</sup>) reaction chamber. The water solutions of apfo were irradiated by means of an excimer laser (LambdaPhysik LPX210i) producing a 193nm wavelength beam operating at an energy level of 100 millijoules per pulse at a frequency of 50 pulses per second. The laser beam was focused along the axis of the reaction chamber and covered an 8mm high by 23mm window section of the reaction chamber. A 30w deuterium lamp and Zeiss MMS-UV spectrometer were mounted perpendicular to the axis and approximately in the middle of the reaction chamber to measure the ultraviolet spectrum of the contents of the reaction chamber as a function of time while the sample was exposed to the laser. Various parameters from the experimental system were interfaced to a computer. Samples were exposed to the laser beam until there ceased to be any appreciable change in the spectrophotometric signature of the sample (typically less than about 15 minutes). After exposure to the laser beam, the samples and reference solutions were sent to a laboratory for FTIR analysis.

The following is a summary of the testing results:

1. The laser beam passed through the 50 mm column of distilled water blank essentially unimpeded, and the UV spectrophotometric signature of water did not change as a result of irradiation.
2. The laser beam did not pass through the 50 mm column of apfo - water solution at any of the concentrations tested.
3. Over a period of less than 15 minutes of irradiation, all apfo samples showed significant changes in their UV spectrophotometric signatures.
4. The rate of change of the UV signatures of apfo samples varied over the period of irradiation.
5. The temperature of the apfo samples increased from room temperature to approximately 45°C over the duration of each of the tests runs.
6. Small bubbles formed at the high point of the reaction vessel, presumably as a result of irradiation. The quantity of the generated bubbles appeared to be directly proportional to the concentrations of apfo.
7. FTIR analysis of the irradiated and un-irradiated samples indicated that, in all cases, there were distinct and substantial changes in the FTIR spectra after irradiation with the UV laser.

The following is a summary discussion of the results presented above:

1. Distilled water in the reaction chamber was transparent to the laser beam.
2. Apfo contained in the samples absorbs UV light from the laser.
3. Due to the dramatic change in the UV spectrophotometric signatures of the samples during irradiation, it appears that significant chemical changes occur related to the decomposition of apfo.

4. Because the rate of change of the UV signatures of the apfo samples at first increased and later decreased during a substantially constant irradiation step, it appears that there are a number of sequential chemical reactions occurring in the sample during irradiation, some of which are relatively rapid and some of which are relatively slow.
5. The increase in the temperature of the samples during irradiation suggests that thermal energy is being transferred from the laser beam and additionally may also be the result of heat released from chemical reactions.
6. Since gas bubbles did not appear during the irradiation of the distilled water sample, and the quantity of the gas bubbles appeared to be in proportion to the apfo concentration in the samples, the gas bubbles are thought to be a gaseous reaction product from the laser decomposition of apfo in accordance with this invention.
7. FTIR analysis results showed shifts in both spectral peaks and heights that would be consistent with apfo decomposition.

It will be apparent to those skilled in the art that changes and modifications may be made in the above-described apparatus and process for an ultraviolet laser system for decomposing chemical pollutants in water without departing from the spirit and scope of the invention herein, and it is intended that all matter contained in the above description shall be interpreted in an illustrative and not a limiting sense.

Having described the invention, what is claimed is:

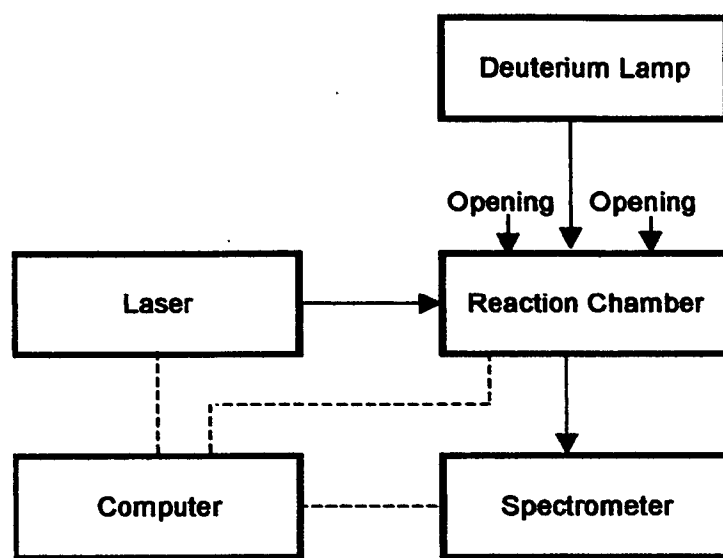
### CLAIMS

1. A method for decomposing chemical pollutants in water to environmentally compatible decomposition products, said method comprising the sequential steps of:
  - (a) passing a portion of water containing one or more chemical pollutants into a reaction chamber;
  - (b) subjecting the water portion in the reaction chamber to ultraviolet laser irradiation of sufficient intensity and for a sufficient period of time substantially to decompose the one or more pollutants to environmentally compatible decomposition products; and,
  - (c) removing a treated water portion from the reaction chamber.

**ABSTRACT OF THE DISCLOSURE**

Apparatus and methods are disclosed for using an ultraviolet laser system to decompose chemical pollutants in water. More particularly, this invention is based on the discovery that various environmental pollutants that are soluble in water can be decomposed to very low concentrations consistent with environmental discharge regulations and/or applicable health standards by means of ultraviolet laser irradiation either with or without one or more catalysts and/or other chemicals to facilitate or enhance the decomposition process.





Laboratory System

Figure 1

Practitioner's Docket No. WLI-001PR**PATENT****IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of: George D. Whitten et al.

☒ Application No.: 60/☒ Filed herewith

For: Ultraviolet Laser System For Decomposing Chemical Pollutants

**POWER OF ATTORNEY FOR PROVISIONAL APPLICATION**

Each inventor, identified above and signing below, hereby appoints the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

*(list name(s) and registration number(s))*

David Silverstein  
Registration No. 26,336

Correspondence address: David Silverstein  
Andover-IP-Law  
44 Park Street, Suite 300  
Andover, MA 01810

Direct telephone calls to: David Silverstein

Tel. No.: ( 978 ) 470-0990

*(check the following item, if applicable)*

☒ Each inventor, identified above and signing below, authorizes the above named attorney(s) and/or agents to accept and follow instructions from his/her representative(s).

	Inventor(s)	Signature
Date: <u>1/31/04</u>	<u>George D. Whitten</u>	<u>George D. Whitten</u>
Date: _____	_____	_____
Date: _____	_____	_____
Date: _____	_____	_____

Practitioner's Docket No. WLI-001PR

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of: George D. Whitten et al.

☒ Application No.: 60 /

☒ Filed herewith

For: Ultraviolet Laser System For Decomposing Chemical Pollutants

**POWER OF ATTORNEY FOR PROVISIONAL APPLICATION**

Each inventor, identified above and signing below, hereby appoints the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

*(list name(s) and registration number(s))*

David Silverstein  
Registration No. 26,336

Correspondence address: David Silverstein  
Andover-IP-Law  
44 Park Street, Suite 300  
Andover, MA 01810

Direct telephone calls to: David Silverstein

Tel. No.: ( 978 ) 470-0990

*(check the following item, if applicable)*

☒ Each inventor, identified above and signing below, authorizes the above named attorney(s) and/or agents to accept and follow instructions from his/her representative(s).

	<b>Inventor(s)</b>	<b>Signature</b>
Date: <u>2/12/04</u>	<u>Allan R. Thompson</u>	<u>[Signature]</u>
Date: <u>2/12/04</u>	<u>Charles W. Moores</u>	<u>[Signature]</u>
Date: <u>2/12/04</u>	<u>Waheed A. Mukaddam</u>	<u>[Signature]</u>
Date: _____	_____	_____